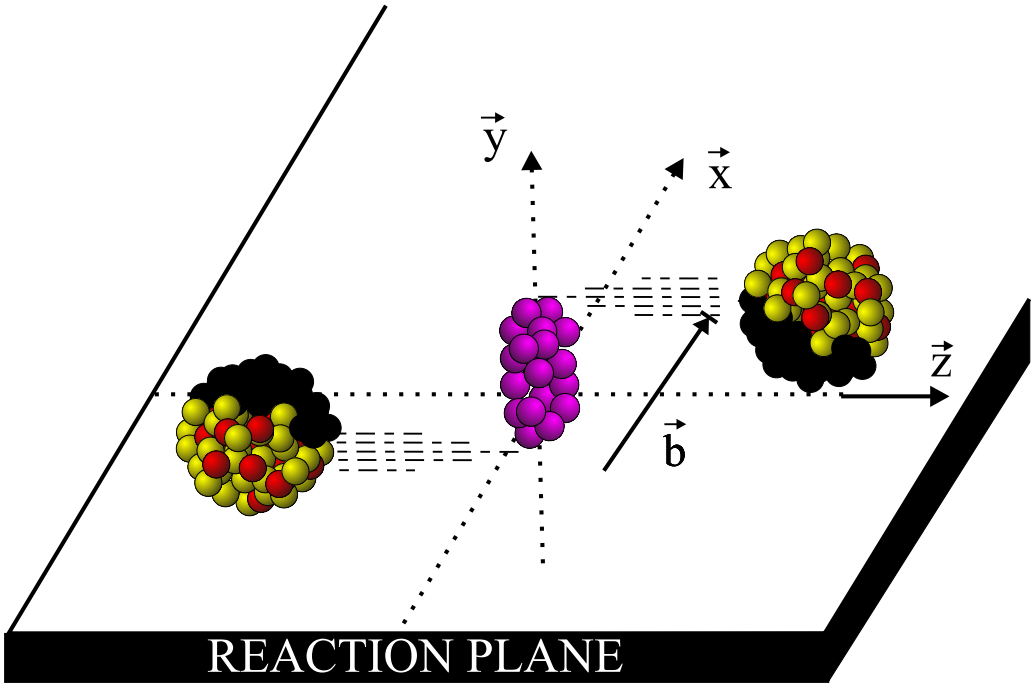
# Anisotropic Flow at

# RHIC

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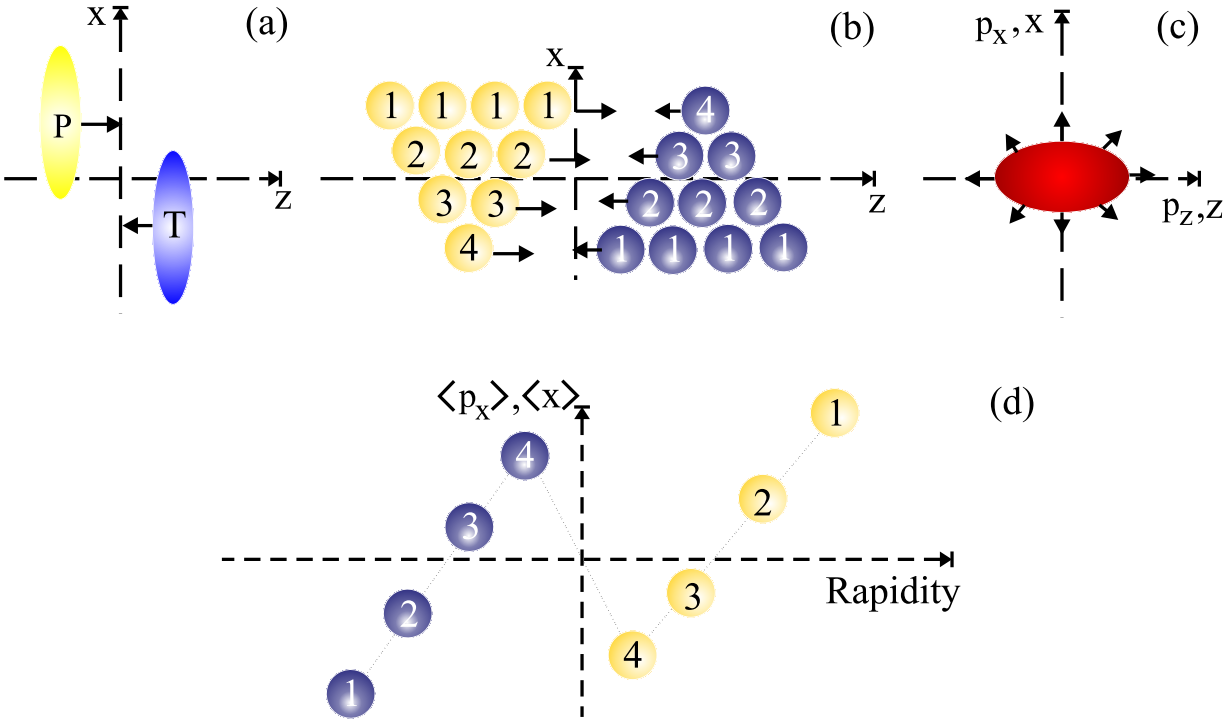
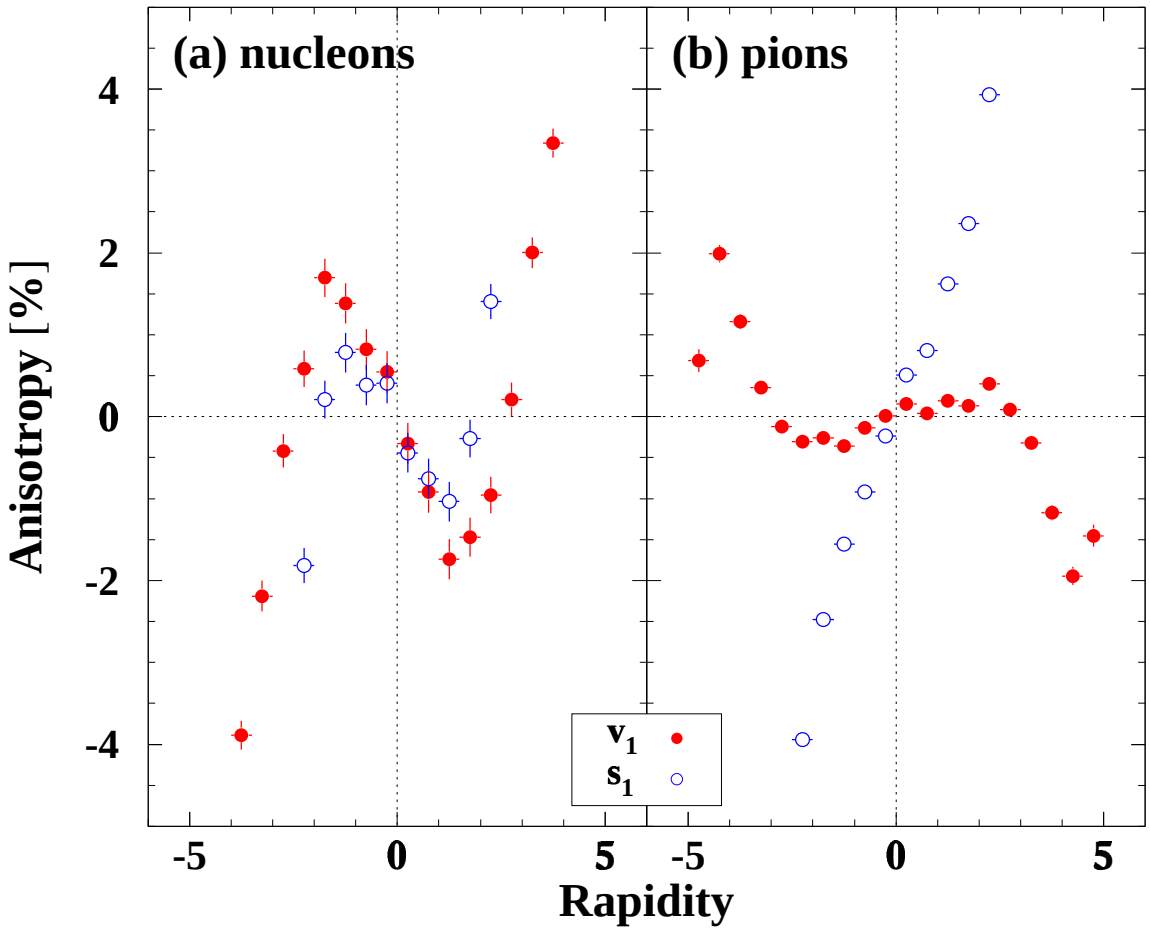
# negative flow (cartoon)



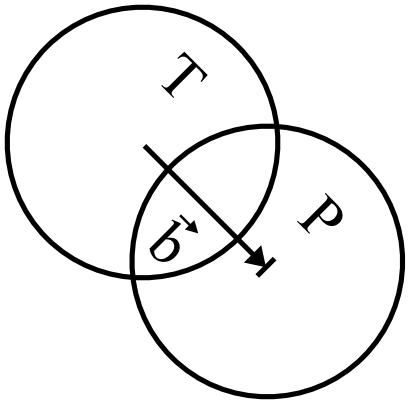
# negative flow (RQMD)

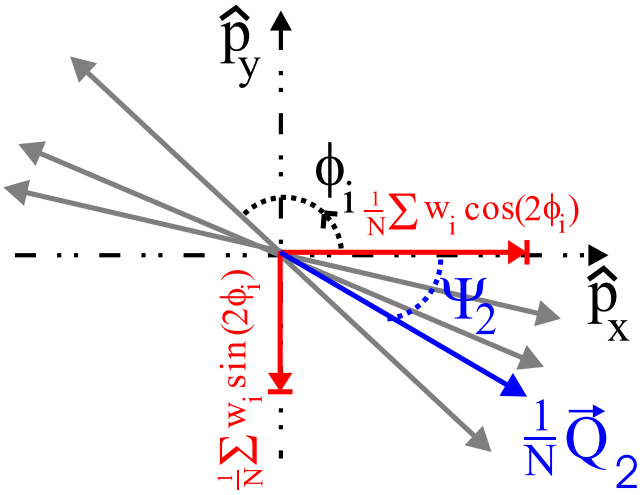



$$v_n = < \cos[n(\phi - \Psi_r)] >$$

$$s_n = < \cos[n(\mathrm{atan}(\frac{y}{x}) - \Psi_r)] >$$

# Flow Equations




- Tags:

4 subevents (a–d) and five harmonics ($n$)

$$\left.\begin{aligned} Q^a_{nx} &= \Sigma_a\, w_i \cos(n\phi_i) \\ Q^a_{ny} &= \Sigma_a\, w_i \sin(n\phi_i) \end{aligned}\right\} \; w_i = -1 \text{ for } \eta < 0 \text{ and } n \text{ is odd}$$

- Analysis:

$$Q_{nx} = Q^a_{nx} + Q^b_{nx}$$
$$Q_{ny} = Q^a_{ny} + Q^b_{ny}$$
$$|Q_n| = \sqrt{Q^2_{nx} + Q^2_{ny}}$$
$$q_n = \frac{|Q_n|}{\sqrt{N}} \quad \text{reduced Q}$$
$$\Psi_n = \tan^{-1}\left(\frac{Q_{ny}}{Q_{nx}}\right) \quad \text{event plane angle}$$
$$\Psi^i_n = \tan^{-1}\left(\frac{Q_{ny} - Q^i_{ny}}{Q_{nx} - Q^i_{nx}}\right) \quad \text{removes autocorrelation of } i^{th} \text{ particle}$$
$$\text{res}_n \approx \sqrt{2} \times \sqrt{\langle \cos(n(\Psi^a_n - \Psi^b_n)) \rangle} \quad \text{resolution of } n^{th} \text{ harmonic event plane}$$

## StFlowTagMaker

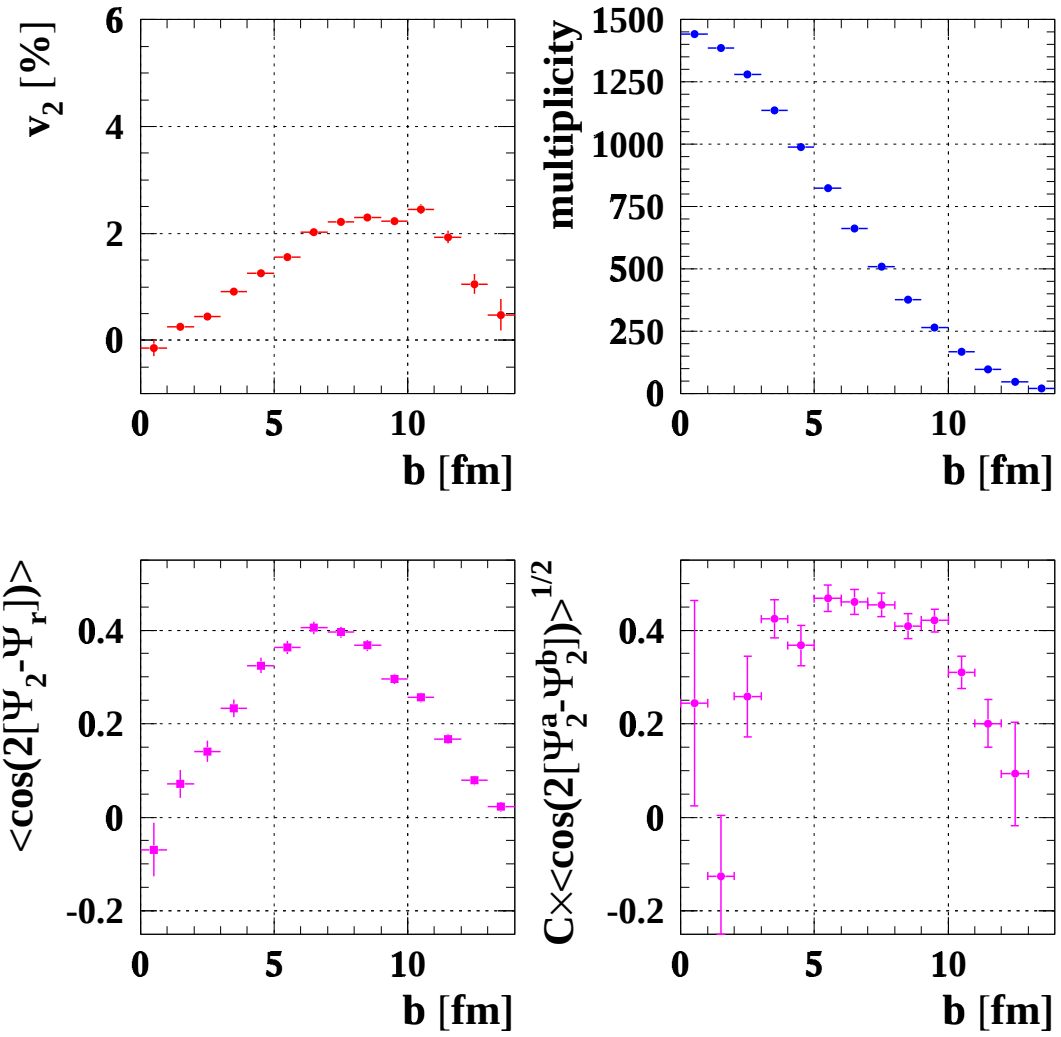
- Stores x and y components of Q vectors of two randomly chosen sub-events
- Does it for harmonics 1 through 5
- Also stores the multiplicity and the sum $p_t$
- Does it without cuts and with cuts
- Does not need particle ID
- Will have provision for making the event plane isotropic in the lab by weighting with the inverse of the particle azimuthal distribution or by recentering in the x,y plane
- Stores and retrieves these constants
- Also public: Division of an event into equal random sub-events (P-CP physics)

## StFlowAnalysisMaker

- Reads the tags
- Calculates event plane angle of full event
- Calculates magnitude of Q for full event
- Removes autocorrelation of a particle with respect to the event plane (reason for storing the x and y components)
- Calculates the event plane resolution from the correlation of sub-event event planes (reason for storing values for sub-events)

# Event plane resolution (STAR Note 388)

*RQMD v2.4, Au+Au 100 AGeV (pions, -1.5≤Y≤1.5)*




$$v_n = \frac{v_n^{\mathrm{obs}}}{< \cos[n(\Psi_n - \Psi_r)] >}$$

$$< \cos[n(\Psi_n^a - \Psi_r)] >= \sqrt{< \cos[n(\Psi_n^a - \Psi_n^b)] >}$$

# Summary / Conclusions

- Determining the event plane gives us $v_n$.
- $v_2$ probably easily accessible in STAR TPC
  resolution shown for 40 000 RQMD events.
  $\leq$ 12 hours beam time at 1 Hz, real "day one" physics
- $v_1$ probably not easily accessible in STAR.
  However, if measurable at RHIC energies:
  Novel rapidity dependence of directed flow?
  Connection between radial flow and baryon stopping?
- Done:
  RQMD events have been converted to XDF files.
  Partly processed by GSTAR using PDSF Linux cluster.
  Have been processed by "bfc.C", using TFS.
  FlowTagMaker written and tested in "doEvents.C".
- To be done:
  Need Slow simulator for real test/results FlowTagMaker.
  FlowAnalysisMaker to be ported to STAR "chain".